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Nonlinear phase conjugate ultrasonic waves in moving media

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The basic principle of acoustic wave phase conjugation provides compensation of phase incursions during back propagation of the phase conjugate waves (PCW) towards the source of the primary emission. This feature of PCW results from time reversal invariance of acoustic field in a stationary medium. In moving media or in the presence of flows the time reversal invariance is broken resulting in essential modification of PCW properties. The incident wave spatial distribution is not reproduced completely by the phase conjugate wave and the phase incursions are not compensated any more. In the present paper the general theory of PCW propagation in moving nonlinear media is developed. The theory is applied for description of PCW acoustic rays and calculation of non compensated phase shift of PCW on the source of the primary probing wave. The treatment of the phase shift of the PCW is developed as a new method of diagnostics and imaging of flow velocity distributions in liquid. The method is approved experimentally on examples of laminar and vortex flows and immersed fluid jet in water. Improvement of quality of the images of flows using nonlinear modes of propagation and interaction of phase conjugate waves is demonstrated.